

Reducing Total Fertilization Failure in In-Vitro Fertilization

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The Challenge

Despite advances in assisted reproductive technology, IVF success rates remain modest, with live birth rates averaging 30% per cycle. A major barrier to success is total fertilization failure (TFF) - a scenario where no oocytes fertilize, abruptly terminating the cycle. TFF occurs in 35% of ICSI cycles and up to 20% of conventional IVF cycles, imposing significant emotional and financial burdens on patients.

The Solution

Using electronic medical records from 15,193 IVF cycles, the researchers applied K-means clustering to group patients based on pre-treatment characteristics and categorized COS protocols according to treatment attributes. Predictive models were then developed for each patient-treatment cluster combination to estimate the likelihood of fertilization success under different COS regimens.

Methodology

Data Collection	15,193 IVF cycles with 52 features: 34 describing patient characteristics and 18 describing COS
Clustering	K-means clustering applied to patient features and COS protocol attributes
Model Training	Random Forest and XGBoost classifiers trained to predict fertilization success
Evaluation	Retrospective comparison of fertilization outcomes between recommended and non-recommended

Results

The retrospective evaluation on 11,947 IVF cycles showed that among the 3,326 cycles (27.8%) that followed the model's recommendations, the total fertilization failure rate was 19.3%, compared to 36.8% across all cycles. This corresponds to a 17% absolute reduction in TFF relative to standard clinical practice.

Significance

- Improved Outcomes:** 17% absolute reduction in total fertilization failure when following model recommendations
- Personalized Medicine:** Bridges predictive modeling with clinical decision support for individualized treatment
- Reduced Burden:** Potential to decrease emotional and financial costs associated with failed IVF cycles

Given that total fertilization failure prematurely terminates the IVF cycle, necessitating additional costly and emotionally taxing treatment attempts, this framework provides a crucial decision-support tool to improve patient outcomes. By systematically optimizing COS selection, this prescriptive analytics approach has the potential to significantly enhance IVF success rates and can be extended to other key decision points in the IVF process.